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Lewis Research Center



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Computer Program for Calculating Aerodynamic Forces on Blade Sections

The problem:

To determine the aerodynamic forces acting on turbomachinery blade sections.

The solution:

A computer program which calculates the aerodynamic forces on turbomachinery blade sections from pressure or velocity distributions along the surfaces. Blade sections for which forces are calculated may have either one or two (tandem) blade segments.

How it's done:

Lift or tangential forces are directly related to energy addition or work input. Blade surface forces due to pressure provide a measure of the "loading" on each blade, where "loading" is defined as the area under the blade surface pressure profile, or the total force on the blade section. For tandem blade sections, tangential forces provide a measure of "work split" between the front and rear segments of the blades. Blade forces are also used for calculating aerodynamic stresses and moments in the mechanical design process.

Input to this program includes blade surface coordinates, surface pressure or velocity distributions, and several overall flow parameters. Spline curves are fitted to the surface coordinates to obtain surface angles, if these are not given as input. Pressure or velocity distributions are integrated around the blades, using the trapezoidal rule, to obtain force components in the input coordinate system directions. Meridional and tangential forces, and lift and drag forces (due only to pressure), are computed from the integrated force components. For tandem blade

sections, ratios of rear blade segment to front blade segment forces are also given.

Care must be exercised in placing points near blade leading and trailing edges. The points in these areas have high surface angle values, with corresponding large tangents used in the integrations. Therefore, input points in these areas must be more closely spaced.

Notes:

1. Three tandem blades with different camber ratios between the blade segments are analyzed with the program.
2. The program is recommended primarily for use with ideal flow pressure distributions where forces in the drag direction can be neglected.
3. This program is written in FORTRAN IV for use on the IBM 7094, and can easily be transferred to other IBM equipment.
4. The program is designed to be used in conjunction with three other programs which calculate blade surface and internal velocity distributions, streamlines, and boundary layers. Together, these programs permit the analytical study of flow through turbomachinery blading. The three additional programs are as follows:
LEW-10743 (M69-10485), FORTRAN IV program for calculating velocities and streamlines in a tandem blade turbomachine; LEW-10789 (M69-10347), program for calculating velocities in magnified region of turbomachines; LEW-11097 (M70-10179), FORTRAN program for calculating compressible laminar and turbulent boundary layers in arbitrary pressure gradients.

(continued overleaf)

5. Requests for further information may be directed to:

COSMIC
Barrow Hall
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Reference: B71-10153

Patent status:

No patent action is contemplated by NASA.

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(LEW-11382)